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FIG. 3 is a flow diagram illustrating a method for operating a base station in the radio communications system 100 of FIG. 1. The method begins at step 302. At step 304, the base station determines if the mobile station (MS) requires a second synchronization word. This determination may be made according to any suitable method, such as by receiving signaling information from the mobile station containing an implicit indicator that the mobile station requires the second synchronization word, or by receiving an identifier or other information from the mobile station and comparing the identifier with stored data to determine the mobile station's transmission requirements. In the embodiment illustrated in FIG. 1, the controller 110 of the base station 102 forms a first means for determining a type of a particular mobile station in radio communication with the base station. Further, the controller 110 forms a second means (110) for determining a type of another mobile station in radio communication with the base station The controller 110 may operate in conjunction with the memory 116 for this purpose, or may operate in conjunction with other data processing equipment of the system, such as the MSC 106.

If the base station determines that the mobile station requires the second synchronization word, at step 306 the base station transmits a first time slot including a first synchronization word. At step 308 the base station then transmits at least the second synchronization word. In this manner, both the first predetermined data symbols (the first synchronization word) and the second predetermined data symbols (the second synchronization word) are provided to the mobile station for accurate demodulation and decoding of the unknown data symbols transmitted in the first time slot by the base station. In the embodiment of FIG. 1, the transmitter 112, alone or in conjunction with the controller 110, forms a means responsive to the type of the particular mobile station for transmitting radio signals to the particular mobile station during a current time slot and during at least a part of a subsequent time slot when the particular mobile station is of a first type. The method then ends at step 310.

If at step 304 the base station determined that the mobile station does not require the second synchronization word, at step 312 the base station transmits the

first time slot and the first synchronization word. With regard to the embodiment of FIG. 1, the transmitter 112, alone or in conjunction with the controller 110, forms a means responsive to the type of the particular mobile station for transmitting radio signals to the particular mobile station during a current time slot and radio signals adapted to a type of another mobile station when the particular mobile station is of a second type. Subsequently, at step 314, the base station determines if the second time slot (i.e., the time slot immediately following the first time slot) has been allocated. The second time slot is allocated if the base station is in two-way radio communication with a second mobile station using the second time slot of the same radio channel. Transmission during the second or subsequent time slot may be suspended or varied if the base station does not communicate with any mobile station during that time slot, or if the mobile station allocated to that time slot is in a different direction. If the second time slot is allocated, at step 316 the base station will transmit the second time slot and the second synchronization word, which are required by the mobile station to which the second time slot is allocated.

If, at step 314, the base station determined that the second time slot is not allocated, at step 318, the base station determines if there is a need to change its radio transmission. Such a need will exist, for example, if the second time slot has been allocated to a mobile station located in a different sector of the geographic area serviced by the base station. If no change is required, control proceeds to step 316 and the second time slot and second synchronization word are transmitted. However, if a change is required, at step 320, the base station makes the necessary change in transmission and, at step 322, transmits the next time slot. The method ends at step 310.

FIG. 4 is a flow diagram illustrating a method for operating a mobile station of a first type in the radio communication system of FIG. 1. The first type of mobile station requires or expects transmission of the second synchronization word by the base station. The method begins at step 402.

At step 404, the mobile station remains in a loop, attempting to locate a control transmission from the base station (BS). If no suitable transmission is

located, the mobile station continues searching. The mobile station may be attempting to initiate a call by beginning two-way radio communication with the base station, or may be attempting to hand over communication from a first base station to a second base station to be located.

In the context of FIG. 1, the receive path 134 forms a means for receiving and decoding a signal from the remote base station. The analog front end 150, the demodulator 152 and the decoder 154 are adapted to perform these functions. The design and implementation of these circuits, including both hardware and software, as well as alternative embodiments, are described more fully in the incorporated references. The new indicator signal provided by the present invention indicates whether the base station transmissions are of the first type or second type. The first type of transmission includes symbols such as a synchronization word in a subsequent time slot which the mobile station 130 may use for decoding the base station transmission. The second type of base station transmission does not reliably include the second synchronization word. The decoder 154, in combination with the controller 138, form a means responsive to the indication for decoding communications signals received from the base station 102, 104 in an allocated time slot of a TDMA frame period. The decoder 154 and controller 138 may be suitably implemented as any combination of hardware or software for performing these functions.

In one embodiment, once a base station has been located, at step 406 the mobile station determines to inform the base station of its need for a second sync word for optimum performance. In other embodiments, no specific implementation of step 406 may occur. Rather, the software or other routine which controls the operation of the mobile station may simply perform the next step depending on the operational mode of the mobile station.

If the mobile station does require a second synchronization word, it may transmit an indicator at step 408. As described above, the indicator may be data or other information contained in signaling, such as control signals. The control signals may be, for example, the electronic serial number (ESN) or mobile identification number (MIN) uniquely associated with the mobile station. The

indicator indicates the type of mobile station to the base station, which in turn determines if the mobile station requires transmission of second predetermined data symbols in a subsequent time slot to its allocated time slot. Alternatively, the indicator can be a specific class mark or protocol version number which is transmitted to the base station and is used by the base station to determine that the mobile station requires transmission of the second synchronization word. Still further, the mobile station may merely transmit identifying information, such as an identifier like its electronic serial number, which is in turn used by the base station to determine transmission requirements of the mobile station.

At step 408, the mobile station receives the first time slot transmitted by the base station and receives at least the second sync word. At step 410 the mobile station demodulates the first time slot with the aid of the second sync word. More generally, the mobile station demodulates and decodes the first time slot using any of the decoding techniques described above in the incorporated references or any other suitable technique. The mobile station determines at step 412 if more time slots are forthcoming or if the call has been terminated. If the call continues, control returns to step 408. If the call has been terminated, the method then ends at step 416.

FIG. 5 is a flow diagram illustrating a method for operating a mobile station of a second type in the radio communication system of FIG. 1. The second type of mobile station does not require or expect transmission of the second synchronization word by the base station. However, in one embodiment, if the second sync word is available, the mobile station of the second type uses the second sync word to optimize its performance. The method begins at step 502. Step 504 proceeds like step 404, described above in conjunction with the mobile station of the first type. At step 506, the mobile station transmits an indicator that the second sync word may be omitted.

If the mobile station does not require a second synchronization word, at step 508 the mobile station of the second type may receive an indication from the base station as to whether the second synchronization word is available. At step 510, the mobile station receives the first time slot including up to the second sync

word. At step 512, the mobile station checks whether the second sync word has been indicated to be available or useful. If so, the mobile station proceeds to step 514 and uses a first demodulation algorithm using the first and/or the second sync word. If not, the mobile station proceeds to step 516 and uses a second algorithm to demodulate the first time slot using the first sync word only. Then at step 518, soft decisions from successive first slots, whether demodulated using the first algorithm at step 514 or the second algorithm at step 516, are de-interleaved and decoded.

If, at step 520, the call should continue, a return is made to step 510 to receive the next first slot. Optionally, control returns to step 508 if a per-slot indication of the availability of the second sync word is provided. Otherwise, if the call has been terminated, the method ends at step 522.

From the foregoing, it can be seen that the illustrated embodiments provide a method and apparatus for accommodating the elimination or modification of transmission of some synchronization words by base stations in a mobile radio communication system. The base station communicates an indication to mobile stations in the region served by the base station that the transmission of subsequent synchronization words will be suspended or varied and are therefore not reliable. In an alternative embodiment, a mobile station may transmit an indicator to the base station that the mobile station requires the second synchronization word, in which case the base station will continue to transmit the second synchronization word for the use of the mobile station.

These embodiments allow the deployment of improved base stations which use more advanced directive antenna arrays that can transmit different time slots of a TDMA frame period in different directions, adapted to the position of the intended receiver. Alternatively, the embodiments permit the use of adaptive power control where the transmission power level in a time slot may be increased or decreased in dependence on the distance of the intended receiver. Both of these variations affect the characteristics of the second synchronization word. Using the illustrated embodiments, such advanced base stations can be adapted to revert to transmission of the second synchronization word with signal continuity to the

previous time slot in order to remain retrospectively compatible with mobile station receivers that rely upon the second synchronization word.

While a particular embodiment of the present invention has been shown and described, modifications may be made. For example, while the synchronization word transmitted in each time slot has been shown for use by the mobile station for demodulating and decoding transmissions from a base station, any predetermined data or symbols contained in a time slot may be used by the mobile station. It is therefore intended in the appended claims to cover all such changes and modifications which follow in the true spirit and scope of the invention.